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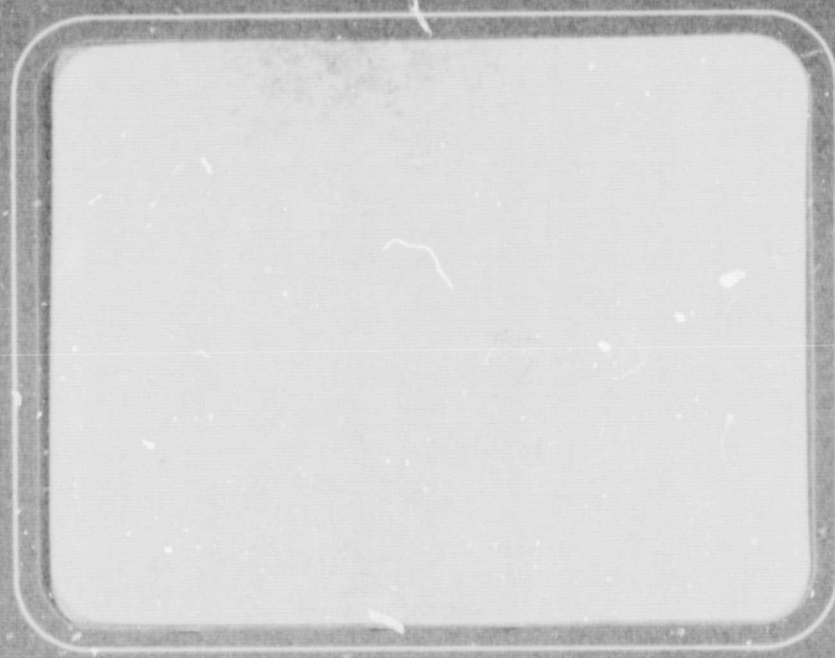
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(NASA-CR-166165) POTENTIAL EFFECTS OF THE INTRODUCTION OF THE DISCRETE ADDRESS BEACON SYSTEM DATA LINK ON AIR/GROUND INFORMATION TRANSFER PROBLEMS (Battelle Columbus Labs.)
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POTENTIAL EFFECTS OF THE INTRODUCTION OF THE
DISCRETE ADDRESS BEACON SYSTEM DATA LINK
ON AIR/GROUND INFORMATION TRANSFER PROBLEMS

By Ralph L. Grayson

March 30, 1981

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POTENTIAL EFFECTS OF THE INTRODUCTION OF THE DISCRETE
ADDRESS BEACON SYSTEM DATA LINK ON AIR/GROUND
INFORMATION TRANSFER PROBLEMS

by

Ralph L. Grayson*

SUMMARY

This study of ASRS reports suggests that benefits should accrue from implementation of DABS Data Link. The Phase I system's ETIS service is expected to provide better terminal information than present systems by improving currency and accuracy. In the exchange of air traffic control messages, discrete address insures that only the intended recipient will receive and act on a specific message. Visual displays and printer copy of messages should mitigate many of the reported problems associated with voice communications. The problems that would remain unaffected include error in addressing the intended recipient and messages whose content is wrong but are otherwise correct as to format and reasonableness.

INTRODUCTION

The study described in this report was an assessment of the Discrete Address Beacon System (DABS) Data Link service. The results have shown that, when implemented, the service may have a favorable effect on many of the communications problems in the national aviation system. The assessment was performed by research staff of the Aviation Safety Reporting System (ASRS) program office at the request of the Federal Aviation Administration (FAA)**.

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** Letter, T. Kossiaras (FAA) to C. Billings (NASA) authorizing the instant study effective May 2, 1979.

The stated objective was "to investigate issues and problems related to verbal communications between pilot and controller and other items of cockpit information where application of data link services either as a supplement to or in substitution for verbal communications is under development or consideration." The investigation consisted of review and analysis of information on verbal communications problems in the ASRS database.

The ASRS database contains information from aviation occurrence reports submitted voluntarily by pilots, controllers, and other participants in the aviation system. The reports are sent to NASA's ASRS program office where they are studied by aviation safety analysts and processed for entry into the computerized database. More than 20,000 reports have been received. Many of these describe problems in air/ground communications.

The assessment related to the currently projected design and usage of DABS Data Link. Assumed system hardware capabilities were extrapolations of the ETIS concept described by Wisleder* and abstracted in the Appendix to this report. Essentially, the assumed system provides a ground sensor station transmitting and receiving graphic messages to and from appropriately equipped aircraft within range, utilizing a discrete beacon code for positive identification of the communicating parties.

The Automated Traffic and Resolution System (ATARS) is an important sub-system of DABS Data Link. It will maintain data on transponder-equipped traffic within a given area and, through track analysis and course prediction, determine if a collision hazard exists. Traffic advisory displays will be presented and, if evasive action is required, will indicate flight paths for separation. In the assessments made in this study, ATARS was assumed to be an integral element of DABS Data Link system capability.

The first stage of field implementation of the system is now expected to be the provision of terminal information in which the automation potential of the system will be utilized. This will be the "Enhanced Terminal Information

* Wisleder, Robert W., May 1979, Enhanced Terminal Information Services (ETIS) Utilizing the Discrete Address Beacon System (DABS) Data Link Concept Description; draft report prepared by Transportation Systems Center, Research and Special Programs Administration, Cambridge, Massachusetts.

System" (ETIS) service in which the present ATIS information plus several other parameters will be collected automatically and disseminated via data link (see Appendix). The major effect of data link in this role will be the elimination of the potential for human error in those classes of information transfer susceptible to automation.

The succeeding stages of implementation are expected by the developers to see DABS Data Link providing selected weather services on request and being used in parallel with the present radio communication system as a means of confirming the verbal messages being transmitted. In this role, data link would provide redundancy in two ways: message duplication via a second medium and message retention for subsequent reference. This dual system mode of operation is expected to be long-term; it is unlikely that the entire aviation system of communications will shift over entirely to data link in the near future.

The ultimate implementation of data link may result in its becoming the primary medium for ATC communications for those aircraft suitably equipped. In this role, full two-way communications would be accomplished with data link providing all forms of information transfer required. In this case, the voice communications system would be a supplement to data link providing redundancy for emergency use and "fine tuning" of transmitted information.

APPROACH

A search was conducted among the 6,527 reports submitted to ASRS between May 1, 1978 and August 31, 1979. The search technique identified and retrieved reports concerning:

- Problems in voice communications between flight crew and ATC
- Problems in conveying information in ATIS broadcasts (as specified in the AIM and FAA ATC Handbook 7110.65A)
- Problems with information concerning wind shear and minimum safe altitude.

Of the original group of reports, 5,402 had been classified as containing a message problem of some type fitting one of these criteria.

The research team studied selected report narratives to establish the generic types of communications problems present. A categorization of these types was developed largely along lines already in use in classifying ASRS report. Ten such categories emerged.

- Misinterpretable--Phonetic Similarity
- Inaccurate--Transposition
- Other Inaccuracies in Content
- Incomplete Content
- Ambiguous Phraseology
- Untimely Transmission
- Garbled Phraseology
- Absent--Not Sent
- Absent--Equipment Failure
- Recipient Not Monitoring

The retrieved reports were grouped according to these categories. The groupings were then further subdivided according to the operational regimes in which the reported incidents occurred (i.e., terminal operations, en route operations, and various special operations). Selections of these were reviewed to determine unique characteristics and common features.

In the last stage of this study, the staff evaluated each type of communications problem as to the effect on it of the developmental DABS Data Link system. Four kinds of effects were considered.

- Eliminate--in practically all instances where a problem of the type appeared it would have been precluded had a data link been in operation.
- Mitigate--in many of the instances where a problem of the type might have appeared it would have been precluded had a data link been in operation.
- Have no effect--in practically none of the instances where a problem of the type might have appeared would the presence of data link have affected the situation one way or the other.

- Exacerbate--in most instances where the problem might have appeared, the presence of an operating data link would have made matters worse.

Also considered were problems in communications or procedures that might be introduced by DABS Data Link. Qualitative conclusions relating to the overall impact of the data link on communications problems emerged from the above evaluations.

DISCUSSION

The initial pass over the database showed that most reports to ASRS (73 percent) involve some type of communication problem related to the operation of an aircraft. Some reports describe more than one such problem. Thus, there is plenty of evidence in the ASRS database pertinent to this study. The nature of the problems reported varies widely covering a range from (a) failure to originate an appropriate message to (b) failure of the intended receiver to comprehend and/or confirm the message accurately. In many of these cases, it is evident without exhaustive examination that data link transmittals, by providing persistent visual portrayals of the messages, might have prevented the problems (although possibly introducing others).

The discussions to follow examine several aspects of the effect of the introduction of data link. First considered is the expectation problem -- the tendency of individuals to allow preconceptions to distort information transferred to them. Second, the ubiquitous problem of transferring traffic information effectively is discussed with special reference to the effect of the ATARS feature. Next, the data link's effect on generic problems in the origin and transmittal of messages is assessed. Following these sections, the discussion moves on to consider several operational sectors of the "control information environment". This environment consists of information transfer flows involving aircraft in three operations regimes: in or near terminals, en route, and conducting various special operations such as military training. In the case of terminal operations, the evaluation is concentrated on two separate aspects: the providing of information about the terminal area itself--the ETIS program --and the control of aircraft ground and

air movements in and near the terminal. Finally, the new problems that data link might introduce are discussed.

The Expectation Problem

A study of ASRS reports indicates that many instances of misunderstanding can be attributed to the expectation factor; the recipient (or listener) perceives that he heard what he expected to hear. Pilots and controllers alike tend to do this. Deviations from routine are not noted and the read back is heard as the transmitted message, whether correct or incorrect.

"Aircraft A was in a block altitude of 12-14M. The instructor pilot and the student both thought the controller told them to turn left to a heading of 010 degrees and descend to and maintain 10,000 ft. At 10,700 ft the controller requested ACFT A's altitude. The crew responded 10,700 ft. The controller stated the aircraft had been cleared to 12,000 ft not 10,000 ft. There are two contributing causes for this occurrence, 99 percent of all clearances from that area are to descend to and maintain 10,000. As the instructor I was conditioned to descend to 10,000 by many previous flights. The controller may have said 12,000 ft but I was programmed for 10,000 ft."

DABS Data Link will not eliminate the expectation factor, of course, but the persistence of the visual message should result in better assimilation of its content as well as providing a means for review during execution. This may reduce substantially the number of incidents resulting from this source of misunderstanding.

Traffic Avoidance Information Problems

ASRS reports suggest that one of the least satisfactory aspects of air/ground communications is the conveyance of traffic advisories and avoidance information. Faults of all kinds are cited, but the pervasive difficulty that appears to underlie many of these faults is the seeming inconsistency with which traffic information is made available.

In the present system, air traffic controllers provide traffic advisories as "an additional service", which means that, workload permitting, the controller will issue advisories when not occupied with other duties. Thus, a pilot may not get advisories during periods of high traffic activity and controller workload when the need for advisories may be the greatest. Furthermore, it is most unlikely that a pilot will get an advisory on aircraft not readily seen on radar -- especially those that are not operating a transponder.

"While descending through 12,200 MSL first officer observed and called traffic 12 O'Clock level as we were turning through 300 degrees. Turn was continued to approximately 320 degrees and other aircraft diverged to the left on a southeast heading with clearance of approximately 1,000 feet laterally. On inquiry, ATC indicated that the only altitude readout on a target in that area was 6,700 MSL. If our aircraft had not been turning in on heading approaching VOR, a projected collision course would have resulted. Situation discussed with ATC supervisor who indicated that a "skin paint" was later picked up on other aircraft but later lost by adjacent center. Other aircraft apparently operating without transponder would be primarily cause of this incident. Contributing would be difficulty in picking up front profile visually at such closing speeds. Other aircraft made no evasive action and we assume he did not observe us."

The ATARS feature of the DABS Data Link system is expected to have a favorable effect on communications by automating the detection of potential conflict situations and then presenting the information to aircraft suitably equipped. ATARS will track all transponder-equipped aircraft in the area of coverage and compute conflict potentials between each aircraft pair (design capacity of the system under development presently is 7500 pairs at each location). When a collision hazard is predicted, cockpit displays will indicate the hazardous areas (from the perspective of each individual aircraft) and the evasive maneuvers best suited to eliminate the danger of a midair collision. This information will be provided instantly and independently of any controller workload priorities. As noted above, this service can be provided via DABS Data Link only to aircraft equipped to receive the data. Conceptually, the use of voice synthesizers for transmission of traffic

advisories and evasive maneuvers could provide automated alert messages to aircraft not equipped to receive ATARS.

Generic Message Problems

Thousands of ASRS reports cite the presence of difficulties in the exchange of information through verbal messages. Some reports concern transfer of information between ground facilities or personnel within such facilities. The greater number of reports concern air/ground communications and a very small number concern air communications alone.

Air/ground communications are conducted by voice radio as they have been for approximately fifty years. During that time technical advances have improved the quality of voice transmissions and mitigated atmospheric or induced electronic interference. Remaining technical problems include blocked transmissions, line of sight limitations and hardware failures that remain undiscovered until the next occasion for a communication--often critical--arises. However, the retrieved ASRS reports concerning problems in air/ground communications indicate convincingly that the majority of such problems involve human error.

These problems have been collected in the ten generic types listed previously. In the subsection discussions that follow, the possible effect of the data link system on each type is assessed.

Misinterpretable--Phonetic Similarity

The "Phonetic Similarity" category was assigned when similar-sounding names or numerics appeared to lead to confusion of meaning and/or intended message recipient, thus causing an information transfer failure. A total of 71 reports were classified in this category. The following narrative is typical.

"We were cleared into position on Runway 32L for an intersection takeoff. After a brief hold in position we received what I thought to be a takeoff clearance. I

then repeated 'Roger, ACR 122 cleared for takeoff, straight out departure.' There was no response from the tower until we were well down the runway approaching V1 speed. The tower controller then said rapidly, 'ACR 122 that clearance was not for you, it was for ACR 142.' We heard no other trip respond to the takeoff clearance but possibly, we responded at the same time as ACR 142 so that tower was unaware that we had both answered and blocked each other's response."

The majority of reported phonetic similarity problems involved execution of clearances by someone other than the intended recipient. The discrete address feature of Data Link should virtually eliminate this since only the intended recipient will receive the message.

Inaccurate--Transposition

In the group of ASRS reports reviewed there were 85 in which some part of the message was misunderstood because of a transmitted or recipient-perceived mis-arrangement of numerical digits within the message. This type of error seems to occur most often when ATC gives assigned headings or distances in conjunction with changes in assigned altitudes in the same clearance. Heading 270 might be heard as a new assigned altitude. The readback then might not be perceived (expectation factor) and an incident might result. One ASRS report illustrates this problem.

"F/O flying-Capt working radio, center gave clearance to descend, (either) (1) to cross 10 DME east at 240 or (2) descend 24 DME east at 10, F/O set 10,000 ft alt and 24 DME, and started descent. Leaving 19,200 center advised we should be at 240. Capt advised we show 10 at 24 DME, but what altitude did he want at this time, he then said maintain 180."

While the accuracy of communications is totally dependent on accurate content in the original message, the visual presentation afforded by DABS Data Link should virtually eliminate such gross transposition errors in message reception. More subtle errors such as hearing 253 instead of 235 are less subject to correction by data link since readers can make such transpositions almost as readily as hearers. However, the fact that the message

remains available for re-checking should help reduce the effect of such transpositions.

DABS Data Link should mitigate the problem of communications that are inaccurate because of transposition.

Other Inaccuracies in Content

A total of 792 reports cited inaccuracies for reasons other than phonetic similarity or transposition. Generally, they involved messages that were accurately transmitted and received, but which contained, or were based on, erroneous data (formulation errors), or, to a great degree, were the results of errors of judgement in the originator's decision. This resulted in the relatively large number of reports in this category.

"Faster Acft B was overtaking Acft A so I issued headings that would provide lateral separation. Later Acft A requested deviation around weather that I did not observe on radar. Thinking that a route direct ABC would maintain lateral separation and provide A with necessary deviation, I issued the clearance. The clearance brought A back south and since I only had five miles in the first place, I immediately lost separation."

Other reports in this group reflect conflicts in the content of the message between the sender and receiver where there is no plausible explanation for the difference in understanding.

"Lift off Runway 31 climbing to 5000 per SID. On initial contact flight was cleared to 12,000. Subsequent transmission received and acknowledged to climb to 14,000 and maintain speed less than 250 knots until 13,000 or above. Traffic was observed at one O'Clock on converging course descending. When our flight left 13,000 ft departure control asked our altitude and advised us to descend to 12,000 and increase speed. No member of the crew either heard or acknowledged such a message."

Although one can only conjecture as to the cause of this incident, use of DABS Data Link would probably have prevented it since written clearance and new assigned altitude could be received only by the addressee and there could be no question as to the stated altitude or speed instructions. Hard-

copy printout in the cockpit, in addition to recorded computer data, would verify what was transmitted. In addition, the newly assigned altitude would appear in the full ATC data block providing additional redundancy.

With respect to the general problem of inaccuracies not stemming from errors in originator judgement, use of DABS Data Link would prevent erroneous receipt of clearances intended for another aircraft and provide graphic symbology that can be re-read as required to decrease the probability of misinterpretation. This would be a considerable improvement over voice communications in accuracy and understanding.

Visual acknowledgement of message content would reduce readback requirements when DABS Data Link is used to confirm voice radio messages. When airborne DABS Data Link equipment includes a printer, a permanent record of the message received can be retained for reference or review.

It follows, however, that data link cannot eliminate the problem of messages that are "inaccurate" because the originator has erred in judgement and therefore produced an incorrect message. As noted above, this is the problem that accounted for the large number of reports classified in this category. However, the system may provide some help. While it can transmit only the information given it by the originator, reasonableness and eligibility checks can be provided to preclude certain types of gross errors. Reasonableness checks can determine whether an item falls within the range of possible correct entries; eligibility checks can determine whether an affected aircraft is under control of the position from which entries are transmitted. Furthermore, with sufficient computer capacity it could be feasible to check the results of an intended clearance amendment via software that would cause an alert or reject message to be returned to the originator if the result would be loss of separation. As heretofore discussed, the ATARS program would provide further redundancy to assure separation.

DABS Data Link should mitigate the inaccurate communications problem; it will help greatly where inaccuracies are caused by formulation errors and may provide some assistance through message checking where inaccuracies are caused by originator judgement error.

Incomplete Content

A reported problem communication was classified as "incomplete" when the originator failed to provide all of the information necessary for the recipient to understand it properly. There were 296 reports classified in this category in the study group.

"Between LIT and FAM we were cleared for a Farmington transition to 30L. To the best of both pilots' recollection, no statement was made by the controller to 'expect a profile descent', when the clearance for a Farmington transition was given. A flight was in the Farmington area climbing to FL230. Upon hearing Acft B talking with center, we volunteered our altitude as being FL240 and we leveled off. I was watching B at FL230 and no evasive action was required."

In this example the requirement for profile descent was not transferred effectively, whether due to input error, failure to comprehend, or a failure of the voice radio system. These failure causes are characteristic of the reports in the "incomplete content" category. DABS Data Link would not, of course, affect non-standard communications that are incomplete because of input error. However, it appears that the latter two failure causes would be mitigated with use of the system.

Ambiguous or Misleading Phraseology

A reported problem communication was classified as ambiguous or misleading if the composition, phraseology or presentation of the message was such that the recipient would tend to misinterpret or misunderstand under normal conditions of receipt. 529 reports indicated this type of message problem. In the following example, a report on a situation rather than an occurrence, the controller reporter points out an ambiguous communication dangerously prevalent in aviation usage.

"Based on my past experiences as a pilot and a flight instructor, I want to make a suggestion. In answer to traffic advisories from a control facility I have heard pilots reply with 'roger' which should never be permitted. It would mean only that the pilot 'understood' but

I have talked with our local controllers about this and they (some at least) take it to mean 'traffic in sight'. My suggestion is that controllers, Fed regulations, GADO, flight instructors and all the Aviation Community with all the power we can muster-require that proper words be used when responding to traffic advisories. Airline pilots are, in my opinion, just as guilty as general aviation pilots. AIM says 'negative contact' and 'traffic in sight' are proper responses.

Ambiguity should be virtually eliminated through use of preformed messages that would state clearly the action intended or the information being provided. While standard terminology would apply to singular message entry, the chance of ambiguity would be lessened by the visual and persistent nature of the cockpit presentation.

Untimely Transmission

Messages were classified as untimely if they originated too late or too early to be useful to the recipient. There were 710 reports that indicated this message problem. The following is an example of a traffic advisory that was too late to avert a critical near midair collision.

"Departure clearance was left turn after takeoff to 120 degrees, climb and maintain 7000. We had just cleaned up and finished the climb check list and at about 4500' departure control gave us VFR traffic at 12 O'Clock less than a mile. The capt spotted the traffic and pointed it out to the F/O who was flying and nosed the aircraft over into level flight to go under Acft B 50 to 100 ft and slightly behind him about 100-200 ft. Acft B saw us just before we passed under and behind him - he flinched just enough to slightly raise his left wing. We feel that radar should have had Acft B in radar contact at the time we took off and we should have been advised of the traffic at or before takeoff."

Aircraft B was evidently transponder-equipped, since he was identified unequivocally as VFR traffic by the departure controller. In this case, ATARS might have provided more timely information to the crew enabling them to avoid a very close encounter.

Dispatching time limits designed into the system can ensure the timeliness of automated message output. Thus, if the air traffic control system fails to provide a traffic advisory at the appropriate time, the ATARS can signal a safe alternative flight path. The system will, of course, have no effect on messages whose dispatch is untimely because of originator judgement error.

Garbled Phraseology

Messages were coded as being garbled if the information content was lost or severely distorted so that recipient was unable to understand it. There were 171 such reports in the study report group.

"Departed on Runway 27 with a right turn to 300 degrees. After takeoff the heading was amended to 330 degrees but the transmission did not come through clear to us and it was mistaken for 030 degrees. Subsequently we learned that our readback to the controller was not received clearly and it was assumed that we had received 330 degrees instead of what we interpreted to be 030 degrees. Obviously, too much assumption, probably assisted by the unusually clear weather. We later learned that our error had brought us in conflict with Acft B that had taken off immediately in front of us. Radar had us less than a mile from Acft B when we passed."

Use of DABS Data Link should reduce this type of error by the clear visual presentation of control instructions whose content can be retained for review as necessary. This type of message problem is encountered often in cases of frequency congestion; it is presumed this problem would not occur with DABS Data Link.

Absent--Not Sent

Problem communications were assigned to the "absent--not sent" category when there was a failure to originate or transmit a required or appropriate message. In the study sample 1991 reports were classified in this message problem subset. The large number is due to a broad interpretation that an appropriate message would have broken the chain of events that resulted in a

hazardous occurrence. This could consist of either a point of information or an air traffic control clearance. Many of these absent messages were traffic advisories not given because ATC either didn't see an aircraft or was too busy (see section on "Traffic Avoidance Information Problems"). The following example is a more subtle omission of an "Expect..." type of message.

"Runway 9R in use - (heading 120 and told to expect a new heading when in the air). The aircraft ahead of me was issued right turn to 240 or 270. I was left on 120. This heading aimed me toward Acft B and I felt very uncomfortable. When tower did not give me an immediate turn, I contacted departure radar expecting the other turn. After radar contact was established, the departure man asked me to go back to tower and upon returning he (tower) told me I should have expected the second turn from him. If tower had issued 'expect further clearance from him', it would have made this clear and concise."

The DABS Data Link system will not provide a solution to the problem of a message missing because of originator oversight. It will eliminate the problem with respect to those items of information that are automatically transmitted by the system. Also, it is expected that the system will ease communications workload, thereby lessening the problem of messages missing because the originator doesn't have time to dispatch them.

Absent--Equipment Failure

Problem communications fell in the category "absent--equipment failure" when a failure caused a complete loss of the message. The study set contained 153 such reports. This finding suggests that the equipment in use is reliable when compared to the human error-initiated problems in message transfer that are reported to ASRS.

"Acft A and Acft B were being vectored to Detroit Metro airport by approach control. Acft C was being vectored to Willow Run airport on the same frequency. The microphone button became stuck on C. As a result the approach controller was unable to communicate with A or B and less than standard separation occurred. The two aircraft were within approximately 500 ft vertically, the pilot of B called the tower controller and advised there was a stuck mike on approach control. The tower controller, using

the information on his radar display, attempted to descend and turn B to avoid the confliction. However, the situation had deteriorated to the point that the confliction could not be avoided. Acft B apparently took evasive action."

Loss of communication is an extremely frustrating experience for an air traffic controller. He is usually helpless to take action to preclude a hazardous consequence. In the above example, one pilot had the presence of mind to contact the tower after noting the approach control frequency was blocked due to the stuck mike, but it was too late to avoid loss of separation.

DABS Data Link would provide a communication channel less susceptible to the "stuck mike" condition. In the event of data link communication loss the redundancy of the voice channel would provide a back-up. One aircraft with an equipment problem such as the one depicted above would be less prone to jeopardize other aircraft under common control. It is unlikely that Data link could fail with the transmit mode "on" (like a stuck mike) since the system's software provides, among other fail-safe features, a length limit within which a message must be transmitted or the transmitter is turned off and failure signals are sent to the operating position.

DABS Data Link can reduce this type of problem in either the primary communication mode or as the alternate or back-up means. In any event, it and the voice communication system would complement one another.

Since it is anticipated that a large number of messages will be generated through automation, these instances, as in the foregoing example, should be greatly reduced. A failure of automation equipment would result in an absent message in the same manner as the human failure to originate or transmit the message. However, the redundancy provided by the unsuccessful message transmission alert should result in improvement over the present system.

As discussed earlier, the ATARS feature would provide a further back-up in those cases where a conflict avoidance message is not transmitted for any reason.

In summary, it is difficult to estimate the degree to which DABS Data Link might ease indirectly the equipment failure problem in air/ground communications but it can, of course, have no direct effect on the reliability of communications equipment.

Recipient Not Monitoring

A problem communication was placed in the "recipient not monitoring" category if the recipient failed to maintain listening watch, proper lookout, or failed to read available correct information. There were 553 reports in this classification.

"A confliction occurred between Acft A on my frequency and Acft B on approach control frequency. A was departing and B was arriving. I was not aware that the B flight was in the area and the confliction was first noted by an approach controller who must have seen what happened. An investigation followed showing that the approach controllers who had handed off A to me failed to coordinate all aspects of control to me as per letter of agreement between our facilities, and I failed to catch the mistake when A came on my frequency. Poor coordination between controllers and not properly listening to the pilot's initial contact were contributing factors in this incident."

A substantial number of reports in this category described the results of traffic advisories not being issued when the reporter alleged or inferred that the traffic could and should have been seen on radar. It may be technically correct that a specific target was not seen due to inattention to the particular area in question and, therefore, the area was not being monitored by the radar controller. It appears, however, that many pilots expect traffic advisories at all times if they have been advised that they are in radar contact. The ATARS feature should provide improvement in this type of problem

both by providing advisory information on a more dependable basis and by providing evasive-maneuver advice.

Another variant of this problem is failure of flight crew or controller to receive a message or initial broadcast or to respond to a call when time is critical. In some reported cases the controller has become aware that his original plan for providing separation was ineffective and he has attempted to correct the situation at the last moment. Lack of instantaneous response gives rise to the allegation that a proper listening watch wasn't being maintained.

Failure to monitor can still occur with DABS Data Link if cockpit distraction or inattention results in failure to heed an incoming message. A message waiting alert could be used to attract attention to an unacknowledged message, but instances could still arise when other events in flight might preclude ready response.

Message Problems Summary

Table 1 is a summary of the conjectured impact of DABS Data Link on the various problem categories in the ASRS database relate to the present reports. In none of the cases would the problem type be worsened. In most cases, data link is expected to mitigate communications problem; it should eliminate two of the problem types.

Terminal Information Problems

This evaluation relates to the proposed Phase I DABS Data Link service described in the reference listed on the first page of this report and in the Appendix. It is a noteworthy feature of the service that most of the information to be provided by ETIS will be automated and provided on a real time basis with the scan rate of the instruments being the only effective limiting factor on currency of the information transmitted. Automated instrument readings would provide either direct or indirect input to the DABS sensor resulting in timely transmission of such pertinent information as wind

TABLE 1. IMPACT OF DABS DATA LINK ON MESSAGE PROBLEMS

Problem Code	No. of Reports	Eliminate	Mitigate	Exacerbate	No Impact
Phonetic Similarity	71	X			
Transposition	85		X		
Other Inaccuracies	792		X		
Incomplete	196		X		
Ambiguous	529	X			
Untimely	710		X		
Garbled	171		X		
Absent	1991		X		
Equipment Failure	153		?		?
Not Monitoring	553		X		

Note: Above evaluations assume the availability of ATARS subsystem with both visual display and automated voice transmission capability.

direction and velocity, visibility, precipitation, and similar data during the approach and landing phase. Departure ETIS data would be provided in the same manner, limited to the items required for that phase of flight.

There are, however, three items that would require manual intervention; these involve specific changes initiated by human decision making, i.e., (1) changes of runways in use, (2) changes of instrument approach procedure, and (3) airport advisories. Since the first two normally occur simultaneously, a single act of intervention should be sufficient. Through the use of coded entries, a single input would cause update messages to be generated and transmitted to all who have a need for the information. This would normally include all aircraft that had received the standard initial arrival ETIS information.

Communications Problems Affected by ETIS

The database was searched for report concerning (1) items of information contained in the present ATIS,* (2) broadcast problems with ATIS, and (3) indications of both a communication message problem and at least one item of either ATIS or the proposed ETIS information. In addition, reports concerning wind shear and minimum safe altitude warning were identified.

An interesting finding of this search was that only a few of the message problem reports were concerned with terminal information services; 50 such reports were retrieved. It had been expected that a large number of reports would describe difficulty in understanding the ATIS broadcasts. Although a considerable number of such reports was received early in the period of ASRS operations (1976 and early 1977), receipt had dwindled to a small rate during the search period on which this study is based. This suggests that improvements have been made in response to several FAA directives aimed at poorly prepared ATIS tapes, use of excessively rapid rates of speech, and technical problems with ATIS broadcast equipment. It may also suggest that airmen may judge difficulty in understanding ATIS to be a minor matter easily overcome by repeating the broadcast and therefore not worthy of an ASRS report. In any case, the majority of terminal information-related reports described problems with ATIS that had substantially more serious consequences than listening to a broadcast a second or third time.

The problems present in the terminal information segment of the retrieved reports fell into a 4-stage classification.

1. Unintelligible Transmissions
2. Obsolete Approach/Runway-in-Use Information
3. Non-Current Runway Visibility Readings
4. Obsolete Weather Information

*Automated Terminal Information System. Items of information included in these broadcasts are specified in the Airman's Information Manual and the FAA Air Traffic Control Handbook 7110.65A.

In addition, the data suggested that the ETIS concept, in mitigating the above problems, might introduce at least one problem not present in the aviation system now; this will be discussed in a separate section.

Unintelligible transmission. - Reporters have cited difficulty in comprehension of the ATIS broadcast due to the rapid rate of speech and the poor quality of the recording.

"On a VFR flight to ICT late in October, I had to listen to the ATIS seven times to get active runway, wind, altimeter setting because of the rate the words were spoken, too fast. As a low time pilot my workload landing at an unfamiliar airport is higher than it should be, check and double check everything and it is unsettling to be unable to get the information needed. Most places I've been that use ATIS, Chicago, Milwaukee, Madison, Rockford, it seems that making the tape has become a chore so it reads as fast as possible to get it over."

"ATIS is supposed to speed up and facilitate arrivals and departures at airports large enough to warrant its installation. This is a wonderful concept. However, on the times that I have been into airports that have it (Boise and Portland) the report has been so distorted as to be all but useless. There is no need for the person recording the information to speak as fast as he can. I do not believe that I should have to listen to ATIS more than three times at the most to have all the information straight. Once should be sufficient. But I have had to listen five minutes or more before I was able to clearly understand what it is the man is actually saying. Without exception, I have not been able to clearly understand the content of the ATIS broadcast the first time simply because the man spoke too fast, and for the lack of a better word, mumbled as he talked."

The basic problem here is garbled message transmission. As pointed out previously in the DISCUSSION section of this report, data link will virtually eliminate this type of problem in whatever context it appears because the information will be presented visually in an orderly format.

Obsolete ATIS data-approach/runway in use. - A frequent complaint from reporters is a change of approach and/or active runway from that given in the ATIS broadcast received by the reporter.

"Planned apr and Lndg for Runway 31R JFK. Prior to turning final runway was changed to 22L and Acft was vectored for ILS or visual apr to Rwy 22L. Visibility approx 5 mi smoke and haze. Our acft was advised being vectored for 22L ILS apr to advs when Rwy in site. Throughout the vector until turning on final we received the 13L ILS identification (IMOH). Both 22L and 31R share a common freq 110.9. We reported this to apch control and were advised the ILS was operating normally on 22L. Not until we were established on visual apch for 22L did the ILS start operating normally with current ident. At this time twr advised that 22L ILS was now operating normally. Not serious in VFR but could be very confusing and possibly cause missed apch in IFR."

Under the ETIS concept runway changes would be disseminated to all aircraft that had previously received "Initial Arrival Information". An update message would be transmitted automatically via DABS Data Link. Coded entries would update the computer data to the new runway configuration. Controller workload would be substantially less than that for update of the ATIS broadcast tape and the pilot would receive immediate notification of the change in the approach procedure.

Runway visibility readings. - Rapidly changing runway visibility readings (RVR) result in both frequency congestion and cockpit distraction at the most critical time in the execution of an instrument approach. Since RVR is not transmitted unless the approach is being conducted in near minimum weather conditions, it is a serious distraction using voice transmissions in the present system. In other cases the RVR appears to have been omitted or the reading was not accurate when it could have been very valuable to the pilot on approach.

"Flight making ILS approach crossing outer marker, tower reported heavy rain at airport. Speed and rate along with localizer and glide slope all were normal throughout approach. Sighted approach lights at 400 ft and began encountering light rain at 300 ft. Runway was in sight and just at touchdown encountered a wall of hard rain and had no forward visibility. I could see by the center line that we were going off the left side of the runway. We soon felt our left main gear was in the lights or possibly off to the left side of the runway. We continued forward velocity for about 1000 ft when we again regained forward visibility at which time the captain was able to

bring the aircraft back over the runway and bring it to a stop."

Had DABS Data Link been available to automatically relay the detailed and apparently rapidly changing RVR to the flight crew, they could have been forewarned of the sharply reduced visibility beyond the touchdown point.

Obsolete weather information. -- Availability of automated weather observation equipment with input to DABS sensors can overcome the problem of currency in the ATIS which results in transmission of obsolete weather information.

"Approach was made VFR--on short final encountered rain (which we thought was light because tower had not reported any). Rain was heavier than anticipated. Normal touchdown--wind from left which was not reported blew us from runway because of hydroplaning. Aircraft came to a stop just off side of Runway 7R.

Precipitation detection equipment and wind measuring devices could have precluded this incident by provision of timely information to the pilot.

In another report the wind shear factor in addition to the obsolescence of the ATIS information proved to be a problem.

"Several aircraft reported moderate to severe turbulence on final approach to the tower. Flight crew monitored approach control and departure control frequencies while waiting for takeoff. To my knowledge arriving aircraft were not advised of "wind shear"/turbulence/airspeed excursions. After our takeoff at 1655 I checked arrival ATIS--no mention of approach difficulties--in fact info was 50 minutes old despite reported hook cloud classically displayed on radar to the SW. I advised local ops of wind problems reported on final, suggesting they advise pilots in range and that MIA dispatch also be advised--that evening about 6 tornadoes hit central GA including extensive tornado damage to Forest Park. Arriving A/C seemed to be left out of the information loop."

DABS Data Link transmission of pertinent weather changes and alerts to possible wind shear conditions could have provided real time information as to current weather and changes that were occurring during a period of great instability. The workload imposed on terminal facilities during thunderstorm activity often results in failure to update the ATIS tape or to provide adequate weather information as reported. Automated instrumentation to provide thunderstorm warning and advice of movement in addition to "wind shear" alerts can provide valuable and timely data to the cockpit allowing improved decision-making based on current and accurate information.

Terminal Operations Problems

The terminal operations evaluation concerned impact of DABS Data Link on communications problems encountered where aircraft under ATC control are performing surface movements or flight operations in the airport traffic area.

Surface Operations

ASRS reports demonstrate the presence of two main types of communications problems related to surface operations: clearance misinterpretations leading to active runway incursions and failures to communicate taxi routes to preclude wrong turns and consequent ground conflicts.

"ATIS was received advising departures on Runway 4, arrivals to Runway 31. Cleared to Runway 4. We switched to tower and advised we were ready for takeoff. The tower said, 'Taxi up to but hold short', which 1st officer acknowledged, but I thought the tower said, 'Taxi into position and hold'. I assumed the traffic was landing on Runway 31. As I took the runway, I looked to my left and noticed an aircraft on about a 3 mile final. The error was caught by me, the tower, and the first officer at the same instant. The tower advised I was supposed to hold short. I immediately cleared the runway well before the traffic landed. Factors which I think contributed were tower deviating from the ATIS information and then not specifically advising us. I have become accustomed to holding in position while an aircraft lands on another runway, and, we are creatures of habit and I thought I heard something I obviously didn't."

Many runway incursion problems appear to result from a flight crew's acting on a clearance onto the runway or for takeoff intended for another aircraft. This occurs most often because of phonetic similarity of call signs or crew predisposition--expectancy. As discussed previously, the discrete address feature of the data link system should eliminate the phonetic similarity problem. While the expectancy factor would still be present, premature movement is less likely to occur since the clearance would not be transmitted until it was to be acted upon; when transmitted, it would be seen only by the intended recipient. As is true in every case, erroneous input that passes reasonableness checks could result in an error. It appears that the number of unauthorized runway incursions could be greatly reduced.

The taxi problem is most often related to flight crew unfamiliarity with airport layout, repairs, and changes; communications problems tend to be secondary.

Flight Operations--Airport Traffic Area

The airport traffic area is the scene of many reported system irregularities. Prominent among these are traffic conflicts with aircraft that are unknown or not properly in the pattern or approach/departure paths, traffic conflicts due to sequencing disorders, use of wrong runways, and deviations from intended aircraft trajectory (course, speed, altitude) during approach or departure phases of flight. The role of communications problems in causing these conflicts is varied but is important in each class.

Conflicts with unknown aircraft. - ASRS reports describe conflicts of this type often occurring when controllers are unaware of the traffic or are too busy to issue advisories. These situations fall under the general headings of absent or untimely communications problems.

"At about the 43 DME fix from XYZ we were cleared to contact approach 127.9. At the same time we contacted approach we witnessed an airplane pass within 300 ft of our right side. When asked about the traffic approach replied he was 'too busy' to call it out. The flight engineer was the first crew member to see conflicting traffic. First officer was flying and capt was tuning

the radios. The flight engineer called traffic to first officer. Traffic was too close to take evasive action. First officer identified aircraft. Upon interrogation on 127.9 approach identified the aircraft as squawking 1200 and an altitude readout of 14,500 ft.

In this example, DABS Data Link might have provided some improvement by a general reduction of the controller communications workload. Whether or not this will happen is dependent on system design and input requirements. If lengthy and complex keyboard entries are required, there may be little reduction in overall workload. However, for routine pilot/controller communications, it appears that computer-generated outputs can be sent with minimal coded entries at least as economically as is done with the current computerized systems.

Another improvement would be the availability of ATARS to provide timely warning and avoidance maneuver information with respect to those aircraft in the area that are equipped with transponders. The DABS Data Link system will have no effect on the problem of unidentified, non-transponder-equipped aircraft.

Sequencing disorders. - Examination of ASRS reports shows that sequencing disorders and their consequent traffic conflicts most frequently are caused by errors in a controller's planning and/or judgement of traffic spacing. Communications problems enter the picture significantly, however, a frequent type of occurrence being the taking of a sequencing control message by an aircraft other than the intended recipient. DABS Data Link's discrete address feature should virtually eliminate this as a source of sequencing difficulties. The tendency to misinterpret or garble such messages is also present and should be overcome by the clarity and referrability of data link information. A possible problem introduced by the data link with reference to sequencing is that the discrete address feature will deny pilots the "party line" information which they now routinely use to form a mental picture of the overall traffic situation in which they are dynamic participants. The "party line" aspect of the data link system is discussed as a separate issue later in this report.

Runway assignment errors. - Use of the wrong runway for landing or taking off is a frequently reported airport traffic area problem. In most cases the fault is a communications problem. Most of the problems involve flight crew misinterpretation of the landing or takeoff clearance--sometimes in connection with a last-minute change in the runway assignment.

"Visibility restricted but VFR. Acft A reported 4 mile final for runway 9, Acft B on right base for runway 12, Acft C was in position for departure at threshold of runway 9, Acft D was holding midfield on taxiway E for departure on runway 9, Acft D was instructed to turn left heading 360 and cleared for takeoff. Instead of departing runway 9, Acft D started takeoff roll westbound on runway 27 toward Acft C and Acft A. He was instructed to abort and stopped on the runway."

The communications errors leading to these problems consist of phonetic similarity, transposition, inaccuracy, ambiguity, garbling, and untimeliness. The expected impact of DABS Data Link on each of these problem types has already been discussed. In summary, it can be expected that the data link system would help to eliminate flight crew misinterpretation of runway assignments.

Deviations from aircraft intended trajectory. - ASRS reports record many instances of aircraft departing from assigned altitudes or headings during approaches or departures in airport traffic area airspace. Communications problems are an important factor in such trajectory deviations, sharing the burden of causation with poor flying technique on the part of flight crew. The majority of the communications problems involved misunderstood clearances; failures to issue appropriate clearances and failures to change frequencies properly also accounted for a significant number of the deviations. It is noteworthy that altitude deviations predominated in this fault category. The data link system should minimize problems with misunderstood clearances through persistent visual portrayal of the message. Alerts to controllers could be provided to indicate the optimum point for a clearance to be issued to arriving aircraft to permit use of the most desirable descent profile. Further, it is within the capability of the system to permit the automation of the frequency change process. This would largely eliminate

control problems arising from human errors in performing this step. Communication channels would be selected by airborne microprocessor/servo systems controlled by data transmitted via DABS Data Link. Channel changes would then be initiated by the airspace and planned flight path being used by the aircraft or manually initiated by the controller.

En Route Operations Problems

The en route operations evaluation concerned impact on communications problems encountered where aircraft under ATC control are cruising en route or transitioning to or from the cruise condition. Many of the problems arising in this flight regime are traceable to difficulties of ATC coordination within and between control facilities. Most of the problems relatable to difficulties in air to ground communication were of three types: altitude deviations, failures of flight crews to respond effectively to clearance amendments for conflict avoidance, and a variety of difficulties related to weather avoidance.

Altitude Deviations

One of the more serious incidents with great potential for mishap is an aircraft being at other than the altitude assigned by air traffic control. This is especially serious when an altitude restriction has been issued during climb or descent. Restrictions are issued because of conflicting traffic and failure to comply will usually result in loss of separation.

Altitude deviations occur for several reasons. These comments will address those embedded in the message problems previously discussed. DABS Data Link will provide a visual presentation of the assigned altitude and intermediate altitude restrictions that can be reviewed as necessary. This should mitigate those deviations arising from failure in message transfer.

A frequently reported occurrence is altitude overshoot due to a cockpit distraction, failure to set the altitude alert properly, or failure to heed the aural or visual signals provided by the alert system. These problems

would not be affected directly by DABS Data Link since, in most cases, the correct data was received in the message transfer.

DABS Data Link should improve the accuracy of cockpit altitude data handling and reduce the frequency of altitude deviations.

Clearance Amendment Response

The previous discussion is applicable to any change in air traffic control clearances. A clear and readily understood message that is not affected by frequency congestion and is transferred as a high priority message will improve clarity and speed, and, since it will be addressed only to the intended recipient, there could be a more timely response. Numerical values, such as altitude and heading assignments, should be readily assimilated, assuming no error in the assignment process and subsequent input.

"Air line crew received a clearance for descent and read back 10000 feet. Crew descended to 10000 and controller asked crew to verify maintaining 11000. Crew responded negative and controller asked them to climb immediately to 11000 and gave them an evasive turn away from other traffic at 10000. ATC said the clearance issued was 11000 but the crew heard and read back 10000."

This misunderstanding could have been prevented with DABS Data Link provided correct input was made.

Weather Avoidance

Avoidance of fronts and thunderstorms is a major factor in en route operations. Deviations from planned routes becomes commonplace and there are frequent incidents involving uncoordinated penetration of airspace assigned to another aircraft or to a different air traffic controller. This problem will not diminish with DABS Data Link except for the general improvement in message transfer.

Weather displays in the cockpit can be improved through CRT presentation via data link of National Weather Service radar data with color coded inten-

sity levels. Availability of such data could be very helpful, particularly if observation of more than one site can be made available. Flight paths can be chosen based on real time evaluation of long range weather patterns in addition to the limited and close range data provided by airborne radar.

Special Operations Problems

Most special operations such as military training or testing of experimental aircraft are non-routine and require scheduling and advance notification to assure their safe isolation from routine aviation activity. A variety of communications problems are associated with them.

- Military Training Routes. A large number of ASRS reports describe close encounters between military aircraft operating on low altitude training routes and civil aircraft near those routes. The associated FSS provides advisories on military training.
- Aircraft Test Operations. These are normally conducted in designated areas but reports indicate two problems. First, the test aircraft may inadvertently fly outside the special use area. Second, other aircraft may penetrate the test airspace due to failure to contact ATC or disregard for the hazard potential in such areas.
- Helicopter Operations. Some reports to ASRS cite helicopter operations as being hazardous to fixed wing operation when the same airspace is used by both types. Other reports by helicopter pilots cite the danger imposed by high performance fixed wing aircraft since the speed differential makes evasive action difficult.
- Parachute Activities. Sky diving and parachute jumping are normally conducted in designated areas during regular time periods. Some reports cite such activities when there is no available information or routine inquiry. Changes of schedules, failure to maintain schedule, failure of interfacility coordination, or failure of pilots to obtain available information can result in a surprise experience.

Information concerning military training routes, aircraft test operations, helicopter operations, and parachute activities is presently made available through Notices to Airmen (NOTAMS) or advisories via voice radio. Current NOTAMS could be made available upon request via DABS Data Link

providing reliable dissemination assuming that the current correct information is entered into the appropriate database.

It would be possible to transmit applicable notices automatically based on the route being flown. If the flight path of the aircraft was projected to enter an area where the notice is applicable, it could be transmitted via DABS Data Link.

Overseas Operation

Communication problems in overseas operations are cited in some report with lack of radar coverage being a primary complaint by air traffic controllers. Separation standards are large due to the foregoing limitations. These problems will not be affected by DABS Data Link, using present VHF transmission links, but there may be potential for its use in conjunction with satellite communication systems and navigation satellite systems in the future.

Law Enforcement

Use of the discrete address feature can provide for communications with aircraft involved in law enforcement activities without interception by others on the standard frequencies for DABS Data Link.

Emergencies

Since there is no "typical" emergency, the application of DABS Data Link would depend on the gravity and the nature of the emergency. Loss of radio communications has been discussed previously; data link would provide a back-up channel. If an airborne emergency required the transmission of complex instructions for remedial action, the printer copy via data link would be an improvement over verbal communications.

Problems Introduced by DABS
Data Link Implementation

While it appears that there will be substantial benefit from the implementation of DABS Data Link, some negative effects must be considered.

Visual Reference to Cockpit Displays

Since the output of DABS Data Link in the cockpit is projected to be a CRT display with a printer hard copy option, it will be necessary for pilots or flight crewmembers to make visual reference to the output copy to receive messages. This will prevent scanning of the surrounding airspace to observe other traffic in the area during the time required to assimilate the data link message. In addition, the visual system must re-adjust when outside scanning is resumed. This could result in failure to observe other traffic in sufficient time to avoid a hazardous situation.

ATARS may reduce this problem by providing positive location information on other aircraft as well as evasive maneuver data. An alternate display system might utilize synthesized voice messages to single-pilot aircraft either in parallel or as a supplement to the visual displays.

Elimination of the Party Line Concept

A popular point of view among pilots is that there is substantial benefit in the "party line" concept: monitoring of a communication frequency can provide useful information on traffic flow, location of other traffic, etc. Many pilots make extensive use of the party line, particularly at non-controlled airports or lower-activity terminals served by a control tower.

"I was in Acft A cleared through the airport traffic area at 2500 MSL. While passing over the field, I heard the tower clear Acft B for takeoff on 31L. He was to climb to 300 MSL on a 270 deg heading. I kept looking, but was unable to see him. The tower never did advise me he was coming. At approx 6 miles west I saw him as he climbed out from under my left wing. He was traveling extremely fast and passed about 200 to 300 feet from me."

Some pilots contend that this is the usual means of acquiring a mental picture of the current traffic situation.

The beneficial use of party line is described in several ASRS reports but in a way only incidental to the primary occurrence since almost all reports concern an unsafe incident or condition. This report is an illustration:

"I was descending to 1500 MSL in Acft A and had been told to enter left downwind for Runway 05, approaching the airport from the northwest. Acft B had just departed Runway 05 and asked for a left turnout to the northwest. The tower approved and said, 'No reported traffic.'. Immediately, - I began looking and saw him approaching me on a collision course. Evasive action was required on my part. Acft B passed my right wing less than a mile. I don't think he ever saw me, because the tower had told him there was no traffic NW of the airport."

The fact that the discrete address feature will eliminate party line among aircraft equipped with DABS Data Link may be considered a disadvantage by many in the aviation community. However, in connection with this perceived disadvantage, several aspects of the party line concept should be examined further.

Party line effectiveness must be evaluated in terms of the number of aircraft on a common frequency that are pertinent to the traffic situation. In large terminals, approach control is sectorized, local control is sometimes divided by the runways in use, ground control is split, and departing aircraft may still be in terminal airspace after being changed to center frequency. In addition, civil aircraft utilize VHF frequencies while military aircraft are normally equipped for UHF communications only; therefore, only the ATC transmissions can be heard on the paired frequency and then only if the controller is transmitting simultaneously on VHF and UHF. Frequency monitoring may include only a fraction of the traffic that could be involved in an incident.

Errors can result from misunderstanding of an overheard transmission. A pilot may initiate an action based on his perception of the message content.

Some ASRS reports concern pilots acting on a clearance heard on party line but intended for another aircraft.

"Acft A was told to taxi into position and hold on Runway 35 while Acft B was on landing rollout. Acft C was told to taxi into position and hold on Runway 23 behind Acft D. Acft B, landing on Runway 33, was holding short of Runway 23. When Acft B turned off Runway 33 and Acft D rolled past the intersection of Runways 23 and 33, Acft A was told to turn right heading 090 after departure, cleared for takeoff. Acft C (holding on Runway 23) thought the clearance was for him and started takeoff roll. Acft A was rolling also. The local controller did not hear Acft C acknowledge for the takeoff clearance nor did he see Acft C start takeoff roll until it was too late. Acft A and Acft C missed by approximately 200 feet at the intersection."

Party line is capable of making additional information available. The relative position and flight path of other aircraft can often be ascertained even when not in view. The intentions of other pilots may be overheard and taken into account in planning future courses of action.

If replacement of this party line information is not provided, there could be justifiable concern among pilots. ATARS, however, may provide an effective presentation of pertinent traffic since it would not be dependent on voice frequency assignment. In addition, it will indicate avoidance maneuvers that take into account all traffic. Since ATARS provides collision avoidance direction in addition to traffic information it may prove to be superior to party line in providing pertinent, accurate, and timely information to the pilot.

Mixed Capabilities During Transition Period

It is anticipated that many aircraft will not be equipped for full utilization of the DABS Data Link system for several years. High performance aircraft and newer production models may be equipped during the early period of availability.

Mixed capabilities of aircraft impose an additional workload on the air traffic control system. The need to consider the varied equipment aboard and the applicable procedures certainly increases the probability of human error.

Aircraft Retrofit

Many current aircraft have crowded cockpit instrumentation. Major redesign may be necessary to provide for installation of DABS display equipment. More will be needed than simply placing a new box in a vacant area. Current wide body aircraft appear to have space available that can accommodate the equipment.

Training Requirements

Specific training would be necessary for users of the DABS Data Link system. Final equipment design would determine some of the requirements such as formats and use of quick action messages. User tests of equipment may be necessary. Air traffic controller training requirements appear to be more extensive than those for pilot/flight crew.

Problems Unchanged by DABS Data Link

Erroneous inputs that are reasonable in their format and content would remain an inherent problem. Some protection against mechanical errors in the input process can be afforded by validity checks that cause gross errors to be rejected as in the case in the present ATC system.

Errors in the decision process would be unchanged by the availability of DABS Data Link. Insofar as the input meets validity criteria the system would be incapable of assessing the correctness or the relative merit of decisions unless their implementation would result in one of the alert conditions such as minimum safe altitude warning.

Hardware failure should be relatively infrequent with state of the art electronics, but system redundancy is the only back-up for a major hardware

problem. The low cost and small size of microprocessors should permit a very high level of reliability through component redundancy, but the ultimate failure of hardware would still render the system unusable.

SUMMARY

This study of ASRS reports suggests that benefits should accrue from implementation of DABS Data Link. The Phase I system's ETIS service is expected to provide better terminal information than present systems by improving currency and accuracy. In the exchange of air traffic control messages, discrete address insures that only the intended recipient will receive and act on a specific message. Visual displays and printer copy of messages should mitigate many of the reported problems associated with voice communications. The problems that would remain unaffected include error in addressing the intended recipient and messages whose content is wrong but are otherwise correct as to format and reasonableness.

APPENDIX

ETIS CONCEPT

APPENDIX

ETIS CONCEPT*

The ETIS concept describes a means whereby various terminal information services are provided to pilots via the DABS data link. It consists of the following elements:

1. A set of terminal information services consisting of various messages containing weather data, airport status, alerts, and other advisories of benefit to a pilot, and dispatched in accordance with the requirements of the different phases of flight in the terminal area.
2. Hardware at airports to collect and input ETIS data, including interfaces with weather sensor systems, displays, input terminals and associated processing equipment, and communication links.
3. Software resident in the DABS data link applications processor (AP) at the controlling ATC facility to generate messages, process input data, handle requests, etc. This processor also performs functions related to other data link applications.
4. Avionics, including displays, keyboard input devices, processors, etc., on board DABS equipped aircraft. These avionics are shared with other DABS surveillance and data link applications.
5. A set of operational procedures and system design characteristics which determine what information is sent at what time and how the pilot and controller access the system.

Figure 1 depicts the proposed ETIS system in a typical installation. A local processor/display system (LPDS), located at the airport, obtains local weather observations from automated weather sensor systems. The controller or airport operator enters certain additional information as required, including runway and approaches in use and NOTAMS. The LPDS display, also installed at the local airport, will, where available, be the Terminal Information Processing System (TIPS) display planned for installation in many

*This description of the ETIS concept was abstracted from: Wisleder, Robert W., May, 1979, ENHANCED TERMINAL INFORMATION SERVICES (ETIS) UTILIZING THE DISCRETE ADDRESS BEACON SYSTEM (DABS) DATA LINK CONCEPT DESCRIPTION; Draft report prepared by Transportation Systems Center, Cambridge, Massachusetts

tower cabs during the mid-1980's. TIPS display/input terminal enables the local controller to access the local ETIS data as well as provide any necessary manual inputs. Also, at most, if not all locations, particularly those with ATIS today, a digital voice system (DVS) is connected to the LPDS processor to provide automatic digitized ETIS voice broadcasts over the VHF channel currently used for ATIS.

At the controlling ATC facility (which may be co-located at the airport) the ETIS information is inputted to the AP via a land line and a modem. The AP may have more than one ETIS input, depending upon the number of airports within coverage of the DABS sensor, that have ETIS capability. Software in the AP controls the communication link with the LPDS processor(s), polling it for data as required and maintaining a table of the most current information. At this facility, controller access to the ETIS data for each airport within its jurisdiction is provided by the TIPS TRACON Display Subsystem.

When a DABS-equipped aircraft, which is bound for a ETIS-equipped airport, reaches a specified area within the coverage of the DABS sensor (60-mile radius), the ETIS software in the AP formats a message whose contents are similar to ATIS of today and dispatches it automatically to the aircraft. As the aircraft proceeds into the terminal area, makes its approach, and lands, pertinent data are automatically dispatched to the aircraft by the AP at the appropriate points in the flight and depending upon the local conditions. Such data may include RVR, significant parameter changes such as altimeter setting, wind shear alert, etc. On a calm, VFR day, it is conceivable that the only ETIS message dispatched after the initial arrival message may be wind on final approach.

In addition to automatic dispatch of ETIS messages, the pilot will have the option of requesting ETIS information for any suitably equipped airport at any point in his flight, as long as the aircraft is within coverage of a DABS sensor. Furthermore, any aircraft whose destination is unknown to the ground (VFR flight, perhaps) will have to request ETIS, or a means provided for communicating the aircraft destination to the ground system. This aspect is discussed in more detail later.

ETIS messages will be displayed in the cockpit using a variety of data link displays which depend on the size of the aircraft and sophistication of avionics that the pilot can afford. Some minimum capability will be required for the number of alphanumeric characters and/or storage registers of the display so that the avionics can handle, although perhaps not display at one time, an entire ETIS message, which includes airport advisories and may be 200 or more characters in length. A CRT or printer type of display provides the most capability for long messages. Display design will be influenced by the other services to be provided by the DABS data link, since it is not likely that any data link service will have a dedicated display (except perhaps ATARS).